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TRANSACTIONS.

SCIENCE IN THE PUBLIC SCHOOLS.

By D. S. KELLY, Emporia, retiring President, before the Academy January 1, 1897.

Within the past 10 years there has been an unprecedented interest awakened in the natural sciences, both in this country and in the old world. The thought is no longer held that a training in the languages, mathematics and metaphysics constitutes an education; but it is well-nigh universally recognized that science and scientific methods must not only be added, but must be given a prominent place. It is agreed that an ideal course of training should be broad, yet not too comprehensive; that it should be liberal, but not too technical; that it should develop rather than inform; and that it should exercise all of the faculties rather than cultivate some at the expense of the others. The introduction of scientific methods in teaching history, etc., has been attended with gratifying results; but the application of the scientific *method* to history can never take the place of science. What the mind needs are facts based upon personal observation and experiment, and these can best be had in the study of natural history. Mathematics begins with axioms and history with recorded facts, both second-hand, and therefore not of the same interest as things observed and handled, from which the pupil gets thoughts from personal knowledge. Doubtless axioms and facts will agitate cerebral protoplasm; so will a rose; and a rose lives in the earth, while axioms and facts live in books and the minds of men. The scientific method applied to history, etc., has made these studies of greater value to the student than before, yet there is needed something the pupil can call his own as gained by personal contact and observation; hence the great value of natural science. In spite of the fact that natural history surpasses all other studies in value as a basis in developing the young minds, it has been most tardy in finding its way into the curricula of studies in our schools. Physics and chemistry found their way into the schools long before biology, because of the supposed utility of them in the practical affairs of life.

The recent establishment of agricultural colleges has emphasized the importance of study in certain lines of science which would give the pupil the power to acquire to be self-reliant; but no institutions have given more impetus to the study of science than scientific associations. This Academy has been the uplift of many a young man who has grown into prominence in his chosen field of research. The work of this Academy in developing talent has been indeed gratifying; and in the development of the material resources and wealth of the state there can be no computation of the value of this Academy. Yet it seems to me that there is a work for this Academy which it has not undertaken as yet. There is an influence which it can and should exert on the public schools of the state. The condition of science in the public schools is not what it should be. One object of this Academy is to encourage scientific study. We believe the study of nature should begin with the child. And yet in a very large majority of the schools of our state no provision whatever is made upon the daily program for this study. Our boys and girls are compelled to seek information from books alone, and thus dull their perceptive and reasoning faculties. Their education is obtained through the cramming process. They come to believe that because a thing is stated in a book it must be so. Eyes have they, but they see not; minds have they, but they reason not. What we need in this country more than anything else, just now, is a system of education that teaches us to examine the facts, gather the data, and upon these base a conclusion. This needs to be taught to all ages, from the kindergarten on up to the college president.

Some few schools are doing good work, systematic work, in science. From such schools there are destined to go out many active observers of nature, and the influence of these schools will be felt in the years to come. And the schools doing the best science work, strange to say, are found in the large cities. This is owing to the energy and interest the superintendent has in such work. He sees the necessities, but is constantly hampered because of the lack of proper material for observation.

There should be an impetus given to this work in our country schools, where the boys and girls are surrounded on all sides by an abundance of material. In many schools the science work has met with what might be regarded as a failure, and there is perhaps no branch of science so poorly taught in our schools (where any is attempted) as zoölogy, and I might add next to this botany. What is the reason for this failure? In most cases the teachers placed in charge of these branches have had no special training in science. They themselves have never learned to observe, and they know nothing of the methods which should be used in such work. Too frequently these branches are given to some teacher whose chief work is in some other line. It is quite easy to predict the result of any work under such conditions. The teacher is forced to treat the subject as he would history or grammar, depend upon the text-book, and the work therefore becomes a pouring in and a memory process. Too frequently the teacher expects too much of the boys and girls, and is constantly forcing them to form conclusions before they have sufficient data of their own; and they soon become discouraged and go to the books for ready formed conclusions.

But the experimentation made in elementary science in the last decade by superintendents and teachers has resulted in much good. They are gradually feeling their way down to the child in this work as in all other subjects. It is claimed by many that a course in natural science cannot be successfully carried out without special teachers. But how ridiculous that seems. If teachers in any public schools had the same training from childhood in natural science that they have had in other subjects, there would attend their efforts the same good results.

The effort for a number of years in the Boston schools attended by failure was due largely to lack of knowledge on the part of teachers, the employment of improper methods, and the use of improper material. When we shall use the children's own elements, the things that are simple to them and within their reach, and discover upon what they work independently with interest, how they work, what methods will best call out their activities and enable them to largely teach themselves, and by what means they can best express their ideas, we shall be on the sure road to successful work. Then there will go out into nature's fields scores of workers where now there is not more than one.

The science of teaching demands a full recognition of an adequate presentation of the subject to be taught. The normal schools rightly claim that a good reproduction naturally follows a good presentation. But unfortunately the reproduction of a subject is too often a failure, because of the *muchness* in presentation. This is especially true in the sciences. The teacher, in making the presentation, sets forth as clearly as possible all the points in the subject. The pupil is left with nothing else to do but reproduce from memory what the teacher has presented. Some teachers acquire great reputation through their skill in developing a subject, logically bracketing-out the syllabus, as some one has said, "on a rod of blackboard." Then comes the reproduction by the pupil, and, if he does not reproduce well, the presentation is thought not to have been clearly done; so it is repeated. This method is said to be psychological and scientific; nevertheless it induces *passivity* (a polite term for laziness), a habit of waiting to be told what to do, and a wrong attitude toward the work of investigation. It is a literary method carried over into science work, with disastrous results.

The very best presentation of a thing is made by the thing itself. The thing must be suitable to the age of the pupils. Experience has shown that when pupils are given simple, natural objects in which they have some interest, and are permitted to observe, draw, and describe in writing, guided only by a few words written upon the blackboard, to show the order of the work, they acquire such a habit of application and power of expression as can be developed in no other way. They are so pleased with the expression of their own ideas that the disposition to appropriate the ideas of others (to save themselves from thinking), or to copy the expressions of others, is entirely counteracted. The most imperative needs of the children are, (1) opportunities to work by themselves; (2) skillful guidance; and (3) generous encouragement.

The "question-and-answer" method is yet a very prevalent one; indeed, it appears to be about the only one known for science by a great many teachers, judging from its general use. In this method the teacher prepares the outlines and questions and determines the probable answers. With a great deal of coaching, he may succeed finally in getting the pupils to give the desired answer. This kind of teaching is very deceptive. A few bright pupils watch the inflections of voice, and can soon tell by observing the teacher's face (instead of observing the natural object) just what the teacher wants them to say, and they say it, while the rest of the class wait to hear what the bright pupils have to tell and try to remember that. The pupils as a whole do not observe or think; and the disposition to make independent investigations is not cultivated.

If the teacher using the question-and-answer method would take a hint from the ludicrous answers frequently given by the pupils, when the objects are beyond their ability to comprehend, and if he would "right about face" and change his objects and methods, there might be some value coming out of such methods. There is a valuable experience to many a boy in eating a green apple.

Here are a few sample answers to questions in teaching elementary science:

1. The *trachea* is the windpipe going from the mouth to the lungs and ramifying throughout all parts of the body.
2. A volcano is a mountain that emits fire, smoke, ashes, and burning saliva.
3. "What is space?" "I can't express it," said the boy timidly, "but I 've got it in my head."
4. What is meant by digestion? We mean by digestion that the food is moistened, so that it will not stick by the way. Food must be digested in order to pass through the stomach. The salivary glands digest it. Glands are muscles on each side of your jaw and in the ears.
5. In a description of the spinal column, the teacher was informed that there is a cushion of gristle in between the vertebræ that goes into the holes every night and comes out every morning; and that is the reason why we are taller in the morning than we are night.
6. Another teacher was informed that some whales produced pearls and others ivory. They make ivory out of whalebone, and sometimes oil.

There is much interest now in elementary science both east and west of us among teachers, but for some reason that wave has not struck Kansas very hard. The executive committee of our State Teachers' Association have been asked again and again to give place on the program for papers and discussions on science. Last year there were two short papers on the program, the only ones which I call to mind in the last 10 years. I believe that this Academy can exert an influence in the direction of bringing about more interest in regard to science in the public schools, and we cannot do a more valuable thing to the state, as well as to the Academy, in perpetuating it in future years. I would recommend that an effort be made to secure a science section in connection with the State Teachers' Association. There is such a section now in the National Association.

One reason for the lethargy in science in our schools is that there is no requirement made in sciences for admission into our colleges and universities. Colleges and universities object to recognizing work in science because inferior work is done in the lower schools. Yes, that is true, and will continue to be true so long as nothing is required of them. There are many high schools now in this state which have extensive courses in languages and mathematics and a mere smattering of science. You ask the superintendent why this is so, and he will tell you he is preparing pupils for the University. Should the universities and colleges require a knowledge of elementary science for admission into their classes, it would at once set a standard of proficiency and give an authoritative call which would be a wonderful stimulus toward putting science into the primary and secondary schools. If it be required of teachers to do a certain kind of work in a certain degree of proficiency, these requirements would soon be met. It is also claimed by college men that the lower schools cannot do the work right, if the teachers had the knowledge, from lack of proper apparatus. I maintain that a certain requirement from our universities would bring the apparatus needed to do the work. It is my judgment that the work in science would soon be done as well in all of the lower schools as in any other subject.

According to our present system, the very best 15 or 20 years of the student's life is robbed of the subject which is of the most worth in giving him a foundation for most efficient work, and the result is that most of the young men and women who enter our normal schools and colleges neither know how nor care to observe. They want to see nature through books. And much of the time allotted to science in our higher institutions must be taken up in teaching the pupils how to observe and making them acquainted with the common things about them; while, if this elementary work had been done in the lower schools, the time in the university could be used to give a deeper insight into nature and nature's laws, in carrying on lines of original investigations such as every student should do before he goes out from these institutions.

Indeed, in many of the higher institutions the course and methods of work would suppose a previous training in observation and an acquaintance with much of nature and her phenomena. The students go out of these institutions into our lower schools, and attempt to teach nature, a thing which they do not know outside of the laboratories. Whoever has not collected insects and plants knows not the halo of interest that old lanes and hedgerows can assume. When a teacher is on fire with a subject, he can fire the pupils with interest. And so a teacher that knows not nature in the fields is not fitted to teach elementary science in our public schools.